

### **Remarks/Arguments**

The Applicant requests the claims following amendment be accepted. The arguments are presented in three parts:

- (A) The invention produced an unexpected result in a new use – inhibiting mold growth in a lignocellulosic thermoplastic composite directly exposed to the outdoor elements.
- (B) Amended claims 10, and 15 and new claim 13 eliminate elements contained in the prior art (Aida).
- (C) The use of colemanite or ulexite in Aida would not provide satisfactory flame retardancy, making Aida's teaching unsatisfactory for its intended purpose.

#### **A. THE PRESENT INVENTION PRODUCED UNEXPECTED RESULTS**

The present invention revealed the surprising discovery that only when the loading of a boron-containing fungicide into a lignocellulosic thermoplastic composite (LTC) reaches the 2 percent level does the fungicide become an effective mold resistant agent. And the fact this resistance is maintained for a long duration under adverse outdoor conditions is also surprising when compared with prior art.

#### **Invention Timeline and Overview**

A Provisional Patent Application (PPA) was filed in Nov. 2002 and the Patent Application 10/681,497 filed on Oct. 8, 2003. Example 1 of the application contained mold data collected in an 18 month outdoor exposure that was initiated in May 2001. The concept of using calcium borate as a fungicide in LTC's was conceived in July 2000.

**The Current Invention: A New Use in a Different Product Produces a Surprising Result**

The addition of zinc borate and calcium borate as a fire retardant in thermoplastic composites (TC) and an anti fungal in lignocellulosic composites (LC) has been identified in prior art. But the current invention adds borates to reduce mold on lignocellulosic thermoplastic composites (LTC) used in products that must withstand outdoor exposure to standing water and UV radiation. This is a new use in a different product. The fact it works to reduce mold growth in this harsh environment is a surprising result.

A Different Product

As described in Dr Clemons paper, *Wood-Plastic Composites, The Interfacing of Two Industries*, LTC's differ from both LC's and TC's. LTC's contain 25 to 75% thermoplastic, incorporate many additives, and are manufactured in a multi-step process which involves mixing of components, compounding of components, and then forming the final product via extrusion or injection molding. Because they contain at least 25% thermoplastic, LTC's have the dimensional stability needed for use in decking and other products that are constantly exposed to harsh outdoor conditions.

In contrast, an LC is composed predominantly of cellulosic strands. An LC is held together with a thermosetting resin that is less than 25% of its overall weight, and usually less than 15%. As a result, even the most robust LC when used outdoors must be coated and confined to a location, such as siding or trim, that does not permit standing water.

Lloyd (USPN 6,368,529) notes that one of these composites is called Oriented Strand Board (OSB) (2-52). The Engineered Wood Association Technical Note at p2 confirms that OSB must be coated, its coating checked regularly, and that it must not have direct contact with water.

A TC is manufactured much like an LTC, but the LTC has additional constraints such as requiring a thermoplastic, such as polyethylene that melts at less than the damage point of wood (200°C). Both TC and LTC products have the robustness to be exposed to a harsh outdoor environment where standing water and UV exposure create complex surface chemistries which cause surface weathering, cracking, and discoloration – issues that are problems in themselves but also increase susceptibility to mold formation. But since it can contain only 25% thermoplastic, or ¼ that of a TC, an LTC is much more susceptible to these surface attacks. Further, a lignocellulosic material, unlike a thermoplastic, provides food for mold.

#### A New Use

When the PPA of current invention was filed, no prior art existed regarding the use of borates to reduce LTC surface impairment due to either mold or weather. In 2003 a study concluded borates wouldn't be effective against LTC mold growth. In May 2005 Dr Laks described the use of zinc borate to restrict mold growth in LTC's, but only if about 3% by weight were incorporated. In July 2005 Manning and Gnatowski, two previous inventors in the field, filed an international patent application claiming zinc borate, calcium borate, and other borates reduced surface impairment caused by exposure to outdoor weather conditions (WO/2006/014428 A1).

A Surprising Result

No prior art existed in May 2001 or even in Nov. 2002 that described the mold resistance of a boron-containing fungicide in LTC. In many cases, these borates were identified as having limited, or no, mold resistance effectiveness in either LC's or TC's. Further, given their wide variation in component elements and a requirement to withstand direct exposure to rain and sunlight, LTC's presented unique and unexpected mold growth challenges that could not have been predicted even if the results from borate additives to TC's or LC's had all been outstanding – which they were not.

An examination of these differences reveals why the results of this present invention were surprising. Mold growth requires a nutrient source and moisture. Cellulose is a mold nutrient; more cellulose means more mold growth. Also, Laks notes that surface roughness can also accelerate mold growth (p9). Both TC's and LTC's are used in decking and railing which are directly exposed to standing water and UV radiation. As a result their surfaces are subject to complex chemical and stressful physical interactions, which can cause cracking and weathering. This increases surface roughness and also allows additional water adsorption into the composite. Although some of the TC's additives, as well as dirt and other foreign particles, can be nutrient sources (Dylingowski p9), its vulnerability is nothing like that of a LTC which can also contain as much as 70% lignocellulosic material – which is food for molds.

Given an LTC can have the cellulosic content about equal to a LC and be exposed to conditions similar to a TC, it was remarkable that the borate-containing fungicides managed to retard mold growth. And, as documented in the Example 1, they did it with samples fully exposed to an outdoor environment –ie. full exposure to standing water and sunlight. As previously noted in July 2005 two inventors in this field stated that the ability of zinc borate to reduce surface impairment simply due to water and UV radiation ( ie. mold attack was not involved in their teaching or studies) was a surprising result.

#### Further Supporting Evidence

*Prior Art: Zinc Borate Was Thought by Experts to Be Ineffective in Providing LTC Mold Resistance for Years After This Invention*

As of May 2005 there were two public studies regarding the use of boron-containing fungicides to reduce surface impairment due to mold in lignocellulosic thermoplastics.

Neither was published at the time the PPA was filed.

On May 20, 2003 Dylingowski presented *Maintaining the Aesthetic Quality of WPC Decking with Isothiazolone Biocide* at the “7<sup>th</sup> International Conference on Woodfiber-Plastic Composites” sponsored by the Forest Products Society. This study compared the effectiveness of two fungicides: Dichloro-Octyl-Isothiazolone (DCOIT-p16) and Zinc Borate (p19) in reducing mold growth in wood-plastic composites. Dylingowski’s presentation contains the following key points:

- a. The list of molds and fungi that can colonize on wood (p3) is not identical to those that can colonize on plastics (p4,7). This implies that a fungicide that is

effective on wood may not be effective on plastic and vice-versa. As a result, one skilled in the art would conclude that if a chemical is ineffective in reducing mold in lignocellulosic or thermoplastic composites it would not work in lignocellulosic thermoplastics. Conversely, effectiveness against mold in those two composites would not guarantee the chemical will be effective in lignocellulosic thermoplastics.

- b. Zinc borate loaded at 1 percent was not effective in resisting 5 types of mold fungi under standard laboratory test ASTM G-21-96 (p 25 to 30), was not effective in resisting a culture of *Aspergillus* (p 31 to 35) and had slight success against 5 types of fungi using MIL.STD.810E testing (p36-39).
- c. Dylingowski concludes that "Zinc Borate did not prevent mold growth in laboratory tests" (p40).

Dylingowski, one skilled in the art of mold growth on wood, plastics, and wood-Plastics, concluded that zinc borate is not effective in restraining mold growth on wood plastics. Further, the data presented on pages 27 & 32 indicates the lack of a dose-response relationship; this leads one skilled in the art to the conclusion that the borate would have no effect even at increased doses. The present invention's discovery that at 2 percent or greater zinc borate does restrain mold growth is an unexpected result. And the fact that it does it for a long period of time under adverse outdoor exposure conditions is even more surprising.

On May 23, 2005, Laks et al published *Effect of Manufacturing Variables on Mold Susceptibility of Wood-Plastic Composites* (copy submitted in Applicants IDS #2). This material was also presented at the "8<sup>th</sup> International Conference on Woodfiber-Plastic Composites" sponsored by the Forest Products Society.

Laks validated the results of the present invention by demonstrating that the use of zinc borate is effective at reducing mold at the 3 and 5 percent levels (p10). He demonstrated, in a laboratory environment, that a surprising change occurs in surface mold's dose-effect response to zinc borate starts between 1 and 3 percent, something demonstrated by this present invention years earlier.

Laks also noted evidence indicated that mold growth was a significant problem on wood plastic decking installations. With 83 publications and 4 patents in the field of wood and wood plastic preservation, the Applicant considers Dr. Laks to be one exceptionally skilled in the art.

Laks states mold growth was a significant problem for the industry, but he and others skilled in the art did not realize until years after the present invention that zinc borate could reduce wood plastic surface mold growth, and then only at 2 percent higher loadings. This shows that Applicant's discovery was not obvious.

*Prior Art: Colemanite Ineffective in Providing Thermoplastic Mold Resistance*

As previously noted, the lack of a fungicide's mold resistance effectiveness in thermoplastics is a good indicator that it will not work well in lignocellulosic thermoplastics.

Koskiniemi's teaching regarding the use of calcium borate in thermoplastics was available prior to the PPA filing. It indicated synthetic calcium borate had to be modified to provide long term mold protection and that colemanite, the naturally occurring form of calcium borate, did not provide this protection even in the short term.

Koskiniemi (USPN 5,482,989) at Example 1, Tables 2 and 3, (4:20 – 5:29) teaches that the lack of resistance to mold growth of thermoplastic samples loaded with 2 percent colemanite (Sample D) was similar to a sample loaded with 2 percent talc (Sample C). This result is particularly remarkable since talc has no fungicidal properties.

Modified calcium pyroborate (Sample A) did provide mold resistance. However the modification required coating with silica to reduce its solubility. Koskiniemi teaches that such coating would be required for plastics that would be placed in use over along time period (2:44-59). But the current invention is designed for wood plastic that will be used on decking and railing for many years.

Koskiniemi tested samples using molds from the *Aspergillus* family, which Dylingowski reveals (p8) is one of the molds that can colonize on wood plastic surfaces. Koskiniemi teaches that indicates colemanite would not be effective at 2 percent loading and further states that without a silica coating synthetic calcium borate would not be effective in the long run. However the current invention discovered that colemanite and non-coated synthetic calcium borate is effective in both the short and long term. Example 1 demonstrated that colemanite was effective in an 18 month outdoor exposure.



*Prior Art: Zinc Borate Ineffective In Providing Lignocellulosic Mold Resistance*

The prior art that existed at the time of the application filing, and even that published at a later date, teaches that zinc borate is not an effective against mold fungi.

Marks, et al (USPN 6,416,789) teaches "...it is known to use zinc borate to protect cellulosic composites, including particleboard, hardboard, and oriented strand board, from fungal decay as described in US Patent Nos. 4,879,083, 5,763,338, and 5,972,266. Zinc borate is usually applied as a powder or a liquid suspension to wood chips or strands, prior to their fabrication into panels. However, zinc borate is not a very cost effective wood preservative, and does not provide good protection against mold, mildew and staining fungi at typical use levels" (1:24-35).

Marks does not provide typical use levels, but recommended use ranges are identified in his referenced patents and also in an EPA document. USPN 5,972,266 (Fookes et al) teaches "...5 to 25 gm of zinc borate per kg of wood strands ..." (1:50-55) or 0.5 to 2.5 percent by weight of zinc borate. USPN 5,763,338 (Sean) at 2:37-49 presents an invention that allows the incorporation of zinc borate in lignocellulosic composites at levels greater than 1 percent.

Finally, the Environmental Protection Agency (EPA) requires the formal registration of any chemical used as a fungicide. As part of this registration process, an applicant must submit a label and an associated technical data sheet describing how the fungicide is to be used. The technical data sheet submitted to the EPA describing the use of zinc borate as a fungicide in wood composites identifies that the loading must be at least 0.5 percent and must not exceed 8 percent depending on the wood species used.

Ross (USPN 7,056,919) teaches "For example, it is known to use zinc borate to protect cellulosic composites, including particleboard, hardboard and oriented strand board, from fungal decay as described in U.S. Pat Nos. 4,879,083; 5,763,338; and 5,972,266. However, like most borates, zinc borate is not particularly effective against mold fungi" (1: 46-52).

*Prior Art: Zinc Borate Somewhat Effective In Providing Lignocellulosic Mold*

In Feb. 2002 Fogel and Lloyd published *Mold Performance of Some Construction Products With and Without Borates*. In Table 4, p40 they present laboratory test results that indicates zinc borate would be somewhat effective in resisting mold in the wood composite called Oriented Strand Board (OSB). The table shows that loadings of 1.08 BAE (1.26% zinc borate by weight) reduced mold growth on the sample but no more than another sample containing 1.76 BAE ( 2.05% zinc borate).

*Prior Art: Zinc Borate is Ineffective in Providing Coating Mold Resistance*

Batdorf (USPN 6,881,247) teaches the addition of a combination of a metal borate, zinc oxide, and magnesium hydroxide to provide an effective antifungal coating additive. His definition of a metal borate includes zinc borate and calcium borate (3:27-29). Batdorf then teaches "metal borates by themselves are not very effective for inhibiting growth over a broad specimen of fungi strains or against many bacteria. However, when used along with magnesium hydroxide, a synergism is obtained resulting in broad and effective protection (3: 62-67)."

*Prior Art: International Patent Claims Borates Reduce LTC and TC Surface Impairment*

In a July 2005 filing, Manning, Gnatowski, et al (WO/2006/014428) state “it has been found, surprisingly, that the addition of zinc borate to many thermoplastic resin compositions reduced the UV degradation of the resin compositions ...” (2: 25-26). Manning, one of the inventors of USPN 6,368,529 and Gnatowski, one of the inventors of USPN 4,879,083 and 5,972,266, state this surprising result would be of benefit to wood plastic composites (5:5 – 7:2).

Borate loading is specified as between 0.1 and 5 % in wood plastics (2:13-15) or preferably between 1 and 3 %, and the authors also note that larger amounts will have a similar effect although it would increase expense (3: 6-12). Calcium borate and boric acid are also identified as suitable boron compounds (3:12-19).

Manning et al describe how the addition of zinc borate has been found to retard the weathering of wood plastic composites (5: 25-30). Finally Applicant notes that the supporting Examples were performed on wood-plastic composites and the results of Example 7, which were laboratory tests, were similar to the field testing results of the current invention.

As inventors of prior art, these authors are clearly persons skilled in the art and it could be argued they are exceptionally skilled in the art. Therefore their teaching -- that the addition of these boron containing chemicals provide resistance to surface impairment by providing UV resistance is a surprising result -- carries significant weight.

Example 1 of the present invention describes that testing on all samples was performed in an outdoor exposure for 18 months. As a result the samples were exposed to UV radiation and direct water contact as well as molds. Therefore the Specification of the current invention identifies that adding a boron-containing fungicides provides resistance to conditions resulting from an outdoor exposure (UV radiation and direct water contact) as well as providing resistance to mold growth.

Summary: A Surprising Result

It was four years after testing of the current invention began before other experts began to lay the foundation required to show that incorporating zinc borate, calcium borate, and boric acid into LTC's reduces surface impairment caused by mold as well as by water and UV radiation. Laks confirmed the mold growth resistance, and the fact that surface roughness could increase mold growth. But as his work was performed in the laboratory, he didn't explore the borates ability to resist water and UV radiation—and by doing so reduces cracking and surface roughness that invites mold growth. Manning, et al recognized that adding these borates reduced surface weathering, but didn't extend this finding, or perform testing to show, that they also reduce mold growth – because cracking reduction reduces mold growth and because these borates themselves have mold resistant properties.

The current invention, in testing conducted in 2001 and 2002, revealed both these properties. The invention's result was very surprising.

**B. AMENDED CLAIMS 10 AND 15 AND NEW CLAIM 13 REMOVE ELEMENTS EXISTING IN THE PRIOR ART**

Claim 10 has been narrowed to only include boric acid, a boron-containing fungicide that is covered in the Specification but not taught in Aida (USPN 5,221,781). Similarly, claim 15 has been narrowed to include only polyvinyl chloride, a thermoplastic not taught in Aida.

New claim 13 eliminates the inclusion of a fire retardant other than zinc borate, synthetic calcium borate, colemanite, ulexite, or boric acid. The Examiner agreed that Aida teaches that if only inorganic flame retardants are used they should be used in combination with organic flame retardants (April 18, 2007 Answer, p9). Claim 13 eliminates organic flame retardants.

Further, Aida requires both a thermoplastic resin and a polyfunctional unsaturated monomer. Claim 13 only contains a thermoplastic resin, eliminating the monomer.

**C. USE OF COLEMANITE AND ULEXITE AT THE 2 TO 12 PERCENT LEVELS OF THE PRESENT INVENTION WOULD RENDER AIDA UNSATISFACTORY FOR ITS INTENDED PURPOSE.**

Claim 9 identifies colemanite as the boron-containing fungicide. The BPAI agreed with the Examiner that Aida teaches the amount of flame retardants, such as zinc borate, could be present in an amount of 5 to 200 parts by weight of the resin. As a result they agreed Aida provided a fair teaching of employing the boron-containing compound in the claimed amount of about 2 to 12% by weight of the composite product.

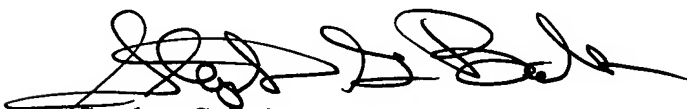
However, Bosserman (USPN 6,723,352) and Pitts (USPN 3,865,760) teach that colemanite and ulexite would not effectively serve as a flame retardant in those ranges, rendering Aida's invention unsatisfactory for its intended purpose if colemanite or ulexite is added in the 2-12 percent range. Bosserman states "'calcium borate ores have been previously used as components in dry powder flame-retardant formulations. One such use was described in U.S. Pat No 3,865,760 to Pitts, et al., wherein the ore colemanite (or alternatively, the ores ulexite or pandermite) was used as a filler in a rubber and plastic dry powder formulation, alone or in combination with alumina trihydrate and calcium carbonate. In this formulation, high levels of un-reacted dry colemanite were required in order to receive the desired flame-retardant effect" (1:64 – 2:6). Pitts Table 1 shows that when colemanite is used alone, a loading of 150 parts by weight of the dry rubber latex is required. At the lowest thermoplastic loading of 25 percent noted in the current invention's Specification, this would require a 37.5 percent loading of colemanite or ulexite.

Lloyd makes no mention of calcium borate as a flame retardant.

#### Summary

For all reasons given above, Applicant respectfully submits the distinctions are of patentable merit under Section 103. Accordingly Applicant submits this application is now in full condition for allowance.

Respectfully Submitted,



Stephen G. Bales  
17 Hart Lane  
Sewell, NJ 08080

**Appendix A**  
**Claims**

1. (Currently Amended) In the method for forming lignocellulosic thermoplastic composite products such as to increase their resistance to surface visual impairment caused by mold attack, the improvement which comprises incorporating an amount of a boron-containing fungicide in the range of from about 2 to 12 percent by weight of said composite product prior to forming said composite product.
2. (canceled)
3. The method according to claim 1 in which said amount of boron-containing fungicide is in the range of from about 3 to about 5 percent by weight of said composite.
4. The method according to claim 1 in which said lignocellulosic material is selected from the group consisting of wood, ground rice hulls, kenaf, jute, and coconut shells.
5. The method according to claim 1 in which said thermoplastic material is selected from the group consisting of polyethylene, high-density polyethylene, polystyrene, and polyvinyl chloride.
6. The method according to claim 1 in which said boron-containing fungicide is calcium borate.
7. (canceled)
8. The method according to claim 6 in which said calcium borate is a naturally occurring borate.
9. (Currently Amended) The method according to claim 8 in which said calcium borate is selected from the group consisting of ~~nebleite~~, ~~gowerite~~, ~~hydroboracite~~, ulexite and colemanite.

10. (Currently Amended) The method according to claim ~~6~~ in which said calcium borate is a synthetic borate. 1 in which said boron-containing fungicide is boric acid.
11. The method according to claim 1 in which said boron-containing fungicide is selected from a group consisting of zinc borate, calcium borate, boric acid, or mixtures thereof.
12. The method according to claim 8 in which said calcium borate is colemanite.
13. (New) In the method for forming composite products consisting of a thermoplastic material, a lignocellulosic material, and at least one of the group consisting of a lubricant, a cross-linking agent, a UV stabilizer, a blowing agent, an inhibitor, and a coupling agent such as to increase their resistance to surface visual impairment caused by mold attack, the improvement which- consists of incorporating an amount of a boron- containing fungicide selected from the group of zinc borate, synthetic calcium borate, colemanite, ulexite, boric acid, or mixtures thereof in the range of from about 2 to 12 percent by weight of said composite product prior to forming said composite product.
14. The method according to claim 1 in which said boron-containing fungicide is zinc borate.
15. .(Currently Amended) The method according to claim 1 in which said ~~lignocellulosic thermoplastic material is wood~~ polyvinyl chloride.